BEDROCK GEOLOGIC MAP OF THE ASHEVILLE 7.5-MINUTE QUADRANGLE, NORTH CAROLINA

NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
DIVISION OF LAND RESOURCES
James D. Simons, Director and State Geologist

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NORTH CAROLINA GEOLOGICAL SURVEY
Geologic Map Series - 14

BY
J. WILLIAM MILLER
AND KAREN H. FRYER
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*Currently with Virginia Department of Mineral Resources
**Currently Environmental Consultant, Decatur, AL.

Field reviews by: Carl Merschat, Mark Carter, Tyler Clark, Richard Wooten, Phil Bradley, and Leonard Wiener.

Map preparation and editing by William Miller, Nick Bozdog, Bart Cattanach, Carl Merschat, and Ken Taylor.

MAP UNITS

ASHE METAMORPHIC SUITE

Late Proterozoic
Stratigraphic relations uncertain

- Zags — Schistose Metagraywacke
- Zag — Metagraywacke
- Zas — Sillimanite-Garnet-Chlorite-Mica Schist
- Zaa — Amphibolite
- Zasc — Chloritoid-Garnet-Chlorite-Quartz-Muscovite Schist

DESCRIPTION OF MAP UNITS

ASHE METAMORPHIC SUITE — The Ashe Metamorphic Suite is predominantly schistose metagraywacke (Zags), less abundant metagraywacke (Zag) and garnet-mica schist (Zas), and minor amphibolite (Zaa) and chloritoid-garnet-chlorite-quartz-muscovite schist (Zasc). Garnet granofels, garnet-biotite schist, actinolite schist, and amphibole-biotite granofels are widely scattered in non-mappable amounts. The protolith of the amphibolite is a mafic rock or a sedimentary derivative of a mafic igneous rock, and the calc-silcate rocks (garnet granofels, garnet-biotite schist, actinolite schist, and amphibole-biotite granofels) originated from sedimentary derivatives of mafic rocks. The sequence in the Asheville 7.5 minute quadrangle is composed dominantly of continentally derived clastic sediments with minor amounts of interlayered volcanics. Deposition occurred in a marine basin. The Ashe Metamorphic Suite has been metamorphosed to sillimanite grade, amphibolite facies. Muscovite porphyroblasts (≤1 cm) are abundant regardless of rock type in varying amounts throughout the quadrangle.

Schistose Metagraywacke (Zags) — Light to medium gray; nonfoliated to weakly foliated; fine to medium grained; granoblastic to lepidoblastic; layering ranges from centimeters to several meters. Consists of 35-58% quartz, 20-41% plagioclase, 2-15% K-feldspar, 10-20% biotite, 0-10% muscovite, 0-5% almandine, widespread traces of zircon, and occasional traces of apatite, calcite, rutile, ilmenite, pyrrhotite, pyrite, and chalcopyrite.

Metagraywacke (Zag) — Light to dark gray; nonfoliated to strongly foliated; fine to medium grained; granoblastic to lepidoblastic; layering ranges from centimeters to several meters. Consists of 20-70% quartz, 10-50% plagioclase, 0-30% K-feldspar, 10-20% biotite, 0-7% almandine, 0-5% muscovite; traces to locally minor epidote, clinozoisite, kyanite, sillimanite, staurolite; and traces of cummingtonite, zircon, apatite, calcite, rutile, ilmenite, magnetite, hematite, pyrrhotite, pyrite, and chalcopyrite.

Garnet-Mica Schist (Zas) — Dark, silvery bluish to greenish gray, strongly foliated, fine to medium grained, lepidoblastic; layering in meters. Consists of varying amounts of micas, with 5-60% muscovite, variable but persistent (1-30%) chlorite and (0-30%) biotite; highly variable (0-65%) quartz, (tr-65%) plagioclase, and (0-33%) almandine; widespread traces of sillimanite; and rare traces of clinozoisite, zircon, ilmenite, magnetite, pyrrhotite, pyrite, and chalcopyrite.

Amphibolite (Zaa) — Black to mottled black and white, weakly foliated, fine- to coarse-grained, hypidioblastic; some fine-grained amphibolites contain hornblende in the main rock matrix as well as porphyroblasts (≤ 2 mm); decimeter to meter-scale layering. Consists of 50-70% hornblende and 25-50% plagioclase, 0-5% biotite, and traces of chlorite, zircon, apatite, calcite, rutile, ilmenite, magnetite, hematite, pyrrhotite, chalcopyrite, and pentlandite (always as inclusions in pyrrhotite). Occurs most often as small tectonized fragments a few meters in outcrop dimension. One 30-meter-thick conformable layer occurs in the central-east end of the Beaucatcher Mountain road cut. Protolith is mafic rock or sedimentary derivative of a mafic rock.

Chloritoid-Garnet-Chlorite-Quartz-Muscovite Schist (Zasc) — Mottled silvery white to silvery medium gray, strongly foliated, fine to medium grained; in meters-thick layers. Consists of 40-70% muscovite, 5-50% quartz, 10-15% chlorite, 10-15% almandine as porphyroblasts (≤1 mm), and 2-10% chloritoid as porphyroblasts (≤ 10 mm), and traces of pyrrhotite and magnetite.

DESCRIPTION OF OTHER ROCK TYPES

The following rock types also occur on the Asheville 7.5-minute quadrangle, but individual bodies are too small and discontinuous to be shown at this scale.

PALEOZOIC INTRUSIVES

Pegmatite — Mottled white to very light gray, nonfoliated, very coarse grained, and lenticular to tabular; thickness ranges from centimeters to meters. Consists primarily of plagioclase and quartz with minor microcline, muscovite, biotite, and garnet. Pegmatites typically cross-cut foliation of other rock units. Not found in mappable units.

Trondhjemite — Very light gray to nearly white; fine to medium grained; granoblastic. Thickness ranges from centimeters to meters. Consists of 50-70% plagioclase, 25-45% quartz, 2% biotite, 5-10% muscovite, and traces of K-feldspar, chlorite, and zircon. Trondhjemites typically cross-cut foliation of other rock units. Not found in mappable units.

MINOR ASHE METAMORPHIC SUITE ROCKS

Garnet Granofels — Mottled pink and white and non-foliated; fine- to coarse-grained garnet-biotite schist is mottled pink and brown and strongly foliated. These two rock types are end-members of the same unit that are distinguished by increasing amounts of biotite from granofels to schist. They may be interlayered or graded between the two end members. Thickness of layering is in decimeters to meters. Consist of 30-40% plagioclase, 30-60% almandine, 2-10% sillimanite, 2-5% biotite, 0-10% K-feldspar; 0-1% each kyanite, muscovite, titanite, and pyrrhotite; and traces of zircon, apatite, calcite, rutile, ilmenite, chalcopyrite, and pentlandite. The largest layer in outcrop reaches 30 meters thick at the northwest end of the Beaucatcher Mountain road cut.

Actinolite Schist — Mottled dark green and white, moderately to strongly foliated, fine- to medium-grained, xenoblastic to hypidioblastic; layering ≤ 4 meters. Consists primarily of actinolite-rich (90%) and actinolite-poor quartzofeldspathic sub-layers < 1 centimeter thick, with 0-90% actinolite, 2-60% quartz, 0-30% K-feldspar (microcline), 3-10% plagioclase, 2-5% biotite, 0-1% titanite, and traces of apatite, calcite, and pyrite. Not exposed in mappable units. One 4-meter-thick layer occurs at the west end of the Beaucatcher Mountain road cut on I-240.

Amphibole-Biotite Granofels — Mottled medium-dark gray, granoblastic to weakly foliated, medium-grained, xenoblastic to hypidioblastic; layer is in meters. One sample from the Beaucatcher Mountain road cut contained 74% plagioclase, 10% chlorite, 5% biotite, 5% hornblende, 5% cummingtonite, and traces of apatite, calcite, ilmenite, hematite, goethite, pyrrhotite, chalcopyrite, and pentlandite.

[1] Mineral adjectives are arranged in order of increasing abundance.

STRUCTURAL FEATURES

CONTACT

Stratigraphic Contact
(inferred)

STRIKE AND DIP OF PLANAR FEATURES

Observation sites are centered on the strike bar, or are at the intersection point of multiple symbols.

- Foliation (37)
- Shear zone (62)
- Joint (63)
- Vertical foliation
- Vertical joint

BEARING AND PLUNGE OF LINEAR FEATURES

- Fold axis (15)
- Vertical fold axis
- Horizontal fold axis
- Mineral lineation (23)

MAP SCALE STRUCTURAL FEATURES

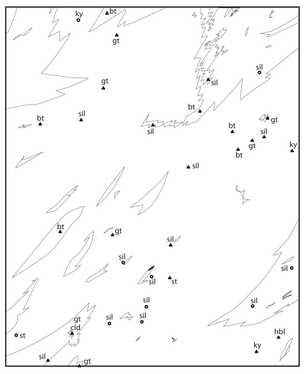
- Axis of map-scale synform inferred
- Axis of map-scale antiform inferred

ELEMENTS OF METAMORPHIC CONDITIONS

Prograde metamorphic minerals observed in stream sediment heavy mineral samples and thin sections shown. Stream sediment heavy mineral sample site localities shown on geologic map.

- Stream sediment heavy mineral sample site
- Thin section sample site

bt - biotite
cld - chloritoid
gt - garnet
hbl - hornblende
ky - kyanite
sil - sillimanite
st - staurolite



TRAVERSE MAP

Green lines show paths of field traverses made to collect geologic control.

MINERAL RESOURCES

PROSPECTS, QUARRIES, AND SAND RESOURCES

Map Number	Description	Latitude; Longitude (decimal degrees)	NC COORDINATES (State Plane, NAD 83 meters)
mi-1	Ethel Rice Heirs mica prospect	35.61565 N; 82.60157 W	212,888N; 283,423E
mi-2	H.D. McDowell mica prospect	35.58047 N; 82.54747 W	208,811N; 288,181E
mi-3	Lora Lee Mathews mica prospect	35.53667 N; 82.61023 W	204,160N; 282,320E
cs-1	Unnamed stone quarry	35.61663 N; 82.53543 W	212,781N; 289,414E
cs-2	Unnamed stone quarry	35.61335 N; 82.51448 W	212,350N; 291,298E
cs-3	Unnamed stone quarry	35.58872 N; 82.54250 W	209,710N; 288,664E
cs-4	Unnamed stone quarry	35.56097 N; 82.59702 W	206,811N; 283,615E
cs-5	Pond Road crushed stone quarry	35.54322 N; 82.60563 W	204,871N; 282,763E
s-1	Harrin's Sand Company dredge	35.56487 N; 82.57882 W	207,183N; 285,279E
s-2	Harrin's Sand Company dredge	35.56497 N; 82.58247 W	207,207N; 284,949E
s-3	Harrin's Sand Company dredge	35.55407 N; 82.59002 W	206,023N; 284,221E

hm-9: Stream sediment heavy mineral sample site. Sample numbers correspond to stream sediment heavy mineral analyses listed in table below.

mi-2: Mineral resource number referred to in accompanying Mineral Resource Summary. Commodity indicated by letter symbol.

COMMODITY LETTER SYMBOLS:

- cs Crushed stone
- mi Mica
- s Sand

- Sand dredging operation
- Abandoned sand dredge
- Abandoned quarry
- Prospect

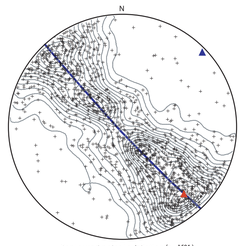
STREAM SEDIMENT HEAVY MINERAL ANALYSIS

Approximately 14 kg of stream sediment was panned to approximately 300 g of heavy mineral concentrate, which was further separated with tetrabromoethane. At least 200 grains were identified with a petrographic microscope and refraction oil of n=1.47.

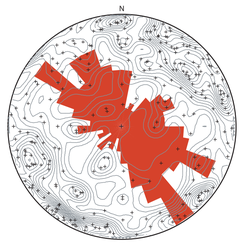
SAMPLE[1]	LATITUDE; LONGITUDE (decimal degrees)	NC COORDINATES (State Plane, NAD 83 meters)	MAP UNITS DRAINED[2]	% hm IN SAMPLE[3]	PERCENT HEAVY MINERALS IN SAMPLE[4]									
					Mag	Op	Gt	Hbl	Zr	Ep	Sil	Rt	Ky	St	Tt
hm-1	35.62073 N; 82.59408 W	213,427N; 284,121E	Zag, Zas	tr	9.4	26.3	3.3	14.1	10.3	12.2	0.0	2.3	4.7	17.4	0.0
hm-2	35.60247 N; 82.51682 W	211,152N; 291,044E	Zag	tr	7.0	22.2	26.4	21.7	5.2	3.8	1.4	0.0	3.3	9.0	0.0
hm-3	35.51542 N; 82.56662 W	201,662N; 286,188E	Zag	tr	33.0	15.4	14.4	6.5	18.1	0.6	8.0	0.9	0.6	2.5	0.0
hm-4	35.52108 N; 82.51963 W	202,137N; 290,469E	Zas	0.04	21.9	30.6	20.3	13.8	7.9	2.1	1.4	0.0	1.0	1.0	0.0
hm-5	35.53452 N; 82.50300 W	203,574N; 292,029E	Zas	tr	70.6	1.6	14.3	3.1	5.2	1.6	0.4	0.0	0.1	2.8	0.3
hm-6	35.53120 N; 82.56302 W	203,399N; 286,577E	Zag, Zas	0.04	18.4	20.9	17.3	7.2	19.3	5.6	5.6	0.4	1.6	3.6	0.0
hm-7	35.52078 N; 82.56493 W	202,250N; 286,362E	Zag	0.08	9.5	33.9	18.7	3.9	11.3	11.7	9.1	0.0	0.0	1.7	0.0
hm-8	35.53613 N; 82.57493 W	203,985N; 285,517E	Zag	0.05	16.8	30.3	16.1	8.1	20.6	2.0	4.0	0.0	0.0	1.6	0.4
hm-9	35.51487 N; 82.58080 W	201,647N; 284,900E	Zag	0.61	3.1	34.3	21.2	15.1	11.6	6.1	3.5	0.0	1.0	3.0	1.0
hm-10	35.51043 N; 82.62042 W	201,285N; 281,291E	Zag, Zas	0.01	29.3	20.5	39.9	0.0	2.3	2.7	0.0	0.0	0.0	5.3	0.0

[1] Sample numbers correspond to heavy mineral sample localities shown on geologic map
[2] Map units contributing to the drainage basin, listed in descending order of map area
[3] Weight percent heavy minerals in stream sediment sample
[4] Weight percent of heavy minerals; Mag=magnetite, Op= opaques other than magnetite in heavy minerals, Gt=garnet, Hbl=hornblende, Zr=zircon, Ep=epidote minerals (epidote, clinozoisite), Sil=sillimanite, Rt=rutile, Ky=kyanite, St=staurolite, Tt=titanite
Monazite was not observed but is expected to occur in Ashe heavy mineral samples.

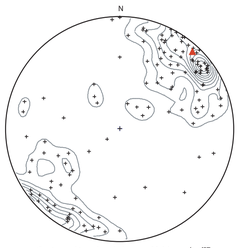
SCHMIDT EQUAL AREA STEREONET DATA



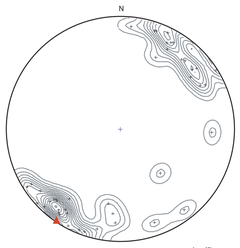
Contoured poles to foliation [1] (n=1,504)
Mean Vector
Calculated fold axis
Best fit great circle



Contoured poles to joints [1] (n=2,960)
Unidirectional Rose Diagram inset



Contoured trend and plunge of fold axes [1] (n=127)
Mean Vector



Contoured mineral lineation orientations [1] (n=430)
Mean Vector

CROSS SECTION A-A'

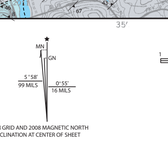
CROSS SECTION B-B'

Topography mapped and edited by the Tennessee Valley Authority
Published by the Geological Survey

Control by NOS/NOAA, USGS, and TVA
Revised by TVA in 1961 by photogrammetric methods using aerial photographs taken in 1960 and by reference to TVA-USGS quadrangle dated 1943. Map field checked by TVA, 1961

Polyconic projection. 10,000-foot grid ticks based on North Carolina coordinate system
1,000-meter Univeral Transverse Mercator grid ticks, zone 17

North American Datum of 1983 (NAD 83) is shown by dashed corner ticks. The values of the shift between NAD 27 and NAD 83 for 7.5-minute intersections are given in USGS Bulletin 1875.



UTM GRID AND 2008 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE APPROXIMATELY 1:24000

CONTOUR INTERVAL 20 FEET
DASHED LINES REPRESENT HALF-INTERVAL CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

QUADRANGLE LOCATION

ASHEVILLE, N.C.
35082-ES-TF-024
1961
PHOTOREVISED 1991
DMA 4455 II SE-SERIES V842